

PATENT
IBM Docket No. FR919990111US1

Amendments to the Specification:

Please replace the following paragraphs beginning with the paragraph beginning on page 6, line 3 and ending with the paragraph beginning on page 11, line 1.:

With reference to Fig. 1, an example of an ATM network 10 implementing the system according to the present invention, and comprising four switching nodes 12, 14, 16 and 18 being respectively connected to local consoles 20, 22, 24 and 26 is illustrated. Each switching node is comprised of a Control Point (CP) blade and a plurality of adapter blades, which provide the physical attachments to network devices such as the other switching nodes or the user workstations and a switch engine (X) providing cell switching between its ports on which are attached the adapter blades. The local console attached to the CP blade in each node is used for the network and control management. Note that each blade includes an input and an output adapters.

It is assumed that a connection in dotted lines depicted in Fig. 1 is established between the source switching node 12 and the destination switching node 18 through the intermediary switching nodes 14 and 16. For this connection, a cell inputs each switching node by an input adapter and outputs the switching node by an output adapter after being switched by the switch engine of the node to be transmitted to the output adapter as a normal connection cell. But, instead of being transmitted over the network, the loopback cell is transferred towards the input adapter of the switching node from which it is returned over the ATM network on the reverse path of the full duplex ATM connection.

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As illustrated in Fig. 2, the transfer of normal ATM cells through a switching node occurs as follows. The ATM cells of a given connection are received by a port P1 of the input adapter B1. They are composed of a ATM label VP1-VC1 (virtual path-virtual circuit) and a payload. First, the protocol engine 38 of adapter B1 identifies the incoming cell using the ATM label lookup 40. The lookup function is an address resolution performed on the source port P1 and the ATM label VP1-VC1. The lookup result is a pointer to the connection control block LCBA1 (leaf control block address). The connection control block contains the information necessary to process the incoming cell, that is information used to run the traffic management function and information used to forward the cell: a switch routing label SRL (B2) and a protocol engine correlator PEC which is the pointer in the output adapter used to perform the label swap (LCBA2). Then, the protocol engine 38 places the cell in an appropriate queue 42. A scheduler using priority based scheduling procedures selects the queue from which the cells are to be transmitted and removes those cells from the selected queue. Then, the append routing header function 44 appends the switch routing label B2 and the protocol engine correlator LCBA2 to the cell which is transmitted to switch engine 46.

Using the appended SRL B2, switch engine 46 transmits the cell to the output adapter B2. Similarly to the protocol engine 38 of the input adapter, the protocol engine 39 of the output adapter identifies the cell by performing a lookup on the appended PEC LCBA2 (48), runs traffic management functions, places the cell in the appropriate

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queue 50 and removes the cell under the control of a scheduler. Then, routing labels B2 and LCBA2 are removed by remove label function 52, and the ATM label is swapped to the new label pointed by LCBA2 in the connection control block, that is VP2-VC2. At last, the protocol engine 39 transmits the cell on destination port P2 also pointed by LCBA2 in the connection control block.

Reciprocally, when a cell is received by port P2 of input adapter B2, its ATM header is VP2-VC2 as illustrated in Fig. 3. The pointer to the connection control block resulting from the label lookup is the pointer LCBA2 which points in the control block to the switch routing label SRL B1 and the protocol engine correlator (PEC) LCBA1 used as pointer to the connection control block in output adapter B1. These two labels are appended to the cell before transmitting it to switch engine 46. Then, in output adapter B1, the routing labels are removed and the ATM header is swapped to VP1-VC1 given by pointer LBA2 in the connection control block of adapter B1.

It is clear from the above description that the connection control block pointers LCBA1-LCBA2 for the P1 to P2 half-duplex connection, are the same as connection control block pointers for the P2 to P1 half-duplex connection. Thus, the connection being full duplex, symmetrical operations are performed on the cell flow received by port P2 of adapter B2 and the cell flow received by port P1 of adapter B1. Such symmetrical operations are being used to achieve the invention as explained hereafter.

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It is assumed now that the incoming cell is a loopback cell to be transmitted to adapter **B2** as illustrated in Fig. 4 before being returned towards adapter **B1**. In such a case, the incoming cell includes an indication that it is a loopback cell to be returned at the output of adapter **B2** towards adapter **B1** instead of being transmitted over the network from port **P2** of adapter **B2**. Therefore, the processing of the cell is the same processing as for a normal connection cell explained in reference to Fig. 2 until the cell is switched by switch engine **46** towards adapter **B2**.

In output adapter **B2**, the protocol engine determines, using the OAM procedures, that the cell has to be returned and sets a loop condition bit in a specific register or in the cell buffer control block. At this stage, it is useful to mention that a loopback may not be allowed in the switching node being considered. For this, a loop control bit has to be set by the control point of the switching node in the connection control block for the loopback to be allowed. If the loop control bit is set, a loopback flag is added to the cell.

After the cell is placed in a selected queue **50** and dequeued, the remove label-ATM label swap function **52** utilizes pointer **LCBA2** to get from the connection control block the information used to forward the cell, that is the target port indication **P2** and the new ATM label used to perform the label swap. Accordingly, the label **VP1-VC1** is replaced in the cell by the label **VP2-VC2** as ATM header, and in view of the loopback flag included in the cell, the pointer **LCBA2** is replaced by the target port indication **P2**. Note that the above steps

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according to the method of the invention can be easily made either by hardware or by software.

Then, due to the loopback flag in the cell, this cell is not forwarded over the network on port P2 as a regular cell of the connection, but is transferred to an "internal port" which is a special port of adapter B2 established between the output part and the input part of adapter B2 used for loopback cells only, and the loopback flag is removed from the cell.

The internal port is in fact an input port for adapter B2 as illustrated in Fig. 5. But, insofar as the cell includes the label P2, the lookup function 40 of the protocol engine applies in a way identical to the one which would be achieved in response to an incoming cell of the connection received on port P2. Afterwards, the remaining steps of the cell processing are identical to the processing steps already described in reference to Fig. 3.

The method according to the invention is represented by the flow chart illustrated in Fig. 6. After an incoming cell has been normally processed in adapter B1, it is received by output adapter B2 (step 60). A check is performed (step 62) to determine whether loopback conditions are met. If so, a loop condition bit is set in a register or in the cell buffer control block (step 64). Then, the label lookup function is performed on the appended PEC LCBA2 to find the connection control block which contains the forwarding information, egress port P2 and ATM label VP2-VC2 at egress port, and the loop

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control bit. If the loop control bit is set (68), a loopback flag is appended to the cell (step 70). Due to the presence of this loopback flag, the SRL B2 and PEC LCBA2 which had been appended to the cell by the protocol engine of input adapter B1, are replaced by the egress port identifier P2 (72), and the ATM label VP1-VC1 is swapped to VP2-VC2 (step 73). Then, the cell is transferred to the input adapter B2 through the internal port of adapter B2 (step 74). In input adapter B2, the cell is processed regularly, i.e. a lookup function is performed on the input port P2 appended to the cell and on the ATM label VP2-VC2, the cell is switched to output adapter B1 and transmitted over the ATM network from output port P1 (step 76). When the cell does not meet loopback conditions or when the loop control bit is not set, the switch routing label B2 and the protocol engine correlator LCBA2 are removed from the cell (step 78), the ATM label is swapped from VP1-VC1 to VP2-VC2 (79) and the cell is transmitted over the network on output port P2 of adapter B2 as all regular cells of the connection (step 80).